
घरेलू और समान विद्युत साधित्रों की सुरक्षा

भाग 2 विवरणात्मक अपेक्षाएँ

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ओवन सहित

(पहला पुनरीक्षण)

Safety of Household and Similar Electrical Appliances

Part 2 Particular Requirements

Section 25 Microwave ovens, including combination
microwave ovens

(First Revision)

ICS 13.120; 97.100.10

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FOREWORD

This Indian Standard (Part 2/Sec 25) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Appliances Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1994. This revision has been undertaken primarily to align the existing standard with the latest international standard.

This standard covers the safety requirements of microwave ovens. This standard however, does not cover the performance requirements which are covered under IS 11676 'Microwave ovens for household and similar purposes'.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

This standard takes into account the requirements of IS 732 : 1989 'Code of Practice for electrical wiring installations (*third revision*)', as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, in case of any deviation, wiring rules take precedence.

If an appliance within the scope of this standard also incorporates functions that are covered by another Part 2 of IS 302, the relevant Part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

When a Part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE — This means that in such a case, it has been decided that for the part 2 standards that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE — Horizontal and generic standards covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IS 302 series of standards.

An appliance that complies with the text of this standard shall not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features which impair the level of safety covered by these requirements.

An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the standard.

This Part 2 is to be read in conjunction with the latest edition of IS 302-1 'Safety of household and similar electrical appliances : Part 1 General requirements' and its amendments. This standard was formulated on the basis of IS 302-1 : 2008.

NOTE — When Part 1 is mentioned in this standard, it refers to IS 302-1.

This Part 2 supplements or modifies the corresponding clauses in IS 302-1, so as to convert that standard into the Indian standard: Particular requirements for microwave ovens, including combination microwave ovens.

When a particular sub-clause of Part 1 is not mentioned in this Part 2, that sub-clause applies as far as is reasonable. When this standard states addition, modification or replacement, the relevant text in Part 1 is to be adapted accordingly.

NOTE — The following numbering system is used:

- a) Subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
- b) Unless notes are in a new sub-clause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- c) Additional annexes are lettered AA, BB, etc.

This standard is based on IEC 60335-2-25 : 2010 (Ed. 6.0) with the following modifications:

Since this standard is to be read in conjunction with IS 302-1 'Safety of household and similar electrical appliances: Part 1 General requirements', the differences of IS 302-1 from IEC 60335-1 would apply.

The principal changes with respect to IS 302-2-25 : 1994 are as follows (minor changes are not listed):

- 1) Microwave ovens for use in corrosive or explosive atmospheres excluded (*see 1.1*);
- 2) Scope is extended by microwave ovens on board ships and Annex **BB** contains requirements and test specifications for microwave ovens on board ships;
- 3) Scope and the requirements for the instructions are modified for better separation between household and similar use and commercial use;
- 4) Scope is modified by so that the standard does not take into account persons whose capabilities or lack of experience and knowledge prevents them from using the appliance safely without supervision or instruction and children playing with the appliance;
- 5) Intended use is defined for clarification;
- 6) ISM frequency bands applicable changed to 300 MHz to 30 GHz (*see 1.1*);
- 7) Few terminologies deleted;
- 8) Water temperature for normal operations and other tests rationalized (*see 3.1.7, 15.101, 32*);
- 9) Test sequence rationalized (*see 5.3*);
- 10) Microwave ovens of class II added (*see 6.1*);
- 11) Rated current for fuse to be marked (*see 7.1*);
- 12) Marking and instructions - requirements added (*see 7.1*);
- 13) Test condition for temperature rise test modified (*see 11.2*);
- 14) Operation for carrying out temperature rise test method (*see 11.7*);
- 15) Requirement for combination microwave oven now modified and covered under Annex **AA**.
- 16) the pollution degree of combination microwave ovens is defined for clarification;
- 17) the thickness requirement for sheaths of visibly glowing heating elements of combination microwave ovens is defined for clarification;
- 18) Clarification on temperature rise measurement of external surfaces (*see 11.8*);
- 19) Leakage current test rationalized (*see 16*);
- 20) the door endurance test is rationalised;
- 21) Endurance test modified, number of cycles increased to 50,000 (*see 18*);
- 22) Abnormal operation test modified (*see 19*);
- 23) There is an editorial correction of **19** of Annex **AA**;
- 24) Stability and mechanical hazards – requirement for appliance normally used on the floor and those used on table are merged (*see 20.101*);
- 25) Mechanical strength test rationalized (*see 21*);
- 26) Modifications for requirements for constructions (*see 22*);
- 27) Replacement of **22.103, 22.104** and **22.105** allows interlock systems with at least one concealed door interlock as well as alternative interlock systems without concealed door interlock;
- 28) Tests on electronic door interlock systems and similar are defined for clarification;
- 29) Modifications for requirements for components (*see 24*);
- 30) Requirement for length of cord modified (*see 25*);
- 31) Requirement of 302-1 now applicable for clearance, creepage distances and solid insulation (*see 29*);
- 32) Requirements for appliances installed in road vehicles caravans etc. to comply with vibration tests (*see 22.116*);

- 33) Clarification for applicability to resistance to heat and fire for appliances with pre selected start time and those with keep-warm function (*see 30.2*); Test for microwave ovens leakage rationalized (*see 32*); and
- 34) differences due to revision of 302-1.

Indian Standard

SAFETY OF HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES

PART 2 PARTICULAR REQUIREMENTS

Section 25 Microwave Ovens, Including Combination Microwave Ovens

(First Revision)

1 SCOPE

This clause of Part 1 is replaced by the following.

1.1 This standard deals with the safety of microwave ovens for household and similar use, their rated voltage being not more than 250 V.

This standard also deals with combination microwave ovens, for which Annex AA is applicable.

This standard also deals with microwave ovens intended to be used on board ships, for which Annex BB is applicable.

Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard. However, if the appliance is intended to be used professionally to process food for commercial purposes, the appliance is not considered to be for household and similar use only.

As far as is practicable, this standard deals with the common hazards presented by appliances that are encountered by all persons in and around the home. However, in general, it does not take into account,

- a) persons (including children) whose,
 - 1) physical, sensory or mental capabilities; or
 - 2) lack of experience and knowledge prevents them from using the appliance safely without supervision or instruction;
- b) children playing with the appliance,

NOTE 101 Attention is drawn to the fact that,

- a) for appliances intended to be used in vehicles or on board ships or aircraft, additional requirements may be necessary; and
- b) in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour and similar authorities.

NOTE 102 This standard does not apply to,

- a) commercial microwave ovens;
- b) industrial microwave heating equipment;
- c) appliances for medical purposes; and
- d) appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas).

2 REFERENCES

This clause of Part 1 is applicable except as follows.

Addition:

IS 302-2-6 : 1993 Safety of household and similar electrical appliances: Part 2 Particular requirements, Section 6 Stationary cooking ranges, hobs, ovens and similar appliances

IS 302-2-9 : 1993 Safety of household and similar electrical appliances: Part 2 Particular requirements, Section 9 Grills, toasters and similar portable cooking appliances

IS 1401 : 2008 Protection of persons and equipment by enclosures — Probes for verification

IS 6873 (Part 4) : 1999 Limits and methods of measurement of radio disturbance characteristics — Part 4 Industrial, scientific and medical (ISM) radio-frequency equipment

IS 9000 (Part 4) : 2008 Basic environmental testing procedures for electronic and electrical items — Part 4 : Damp heat (Steady state)

IS 9000 (Part 8) : 1981 Basic environmental testing procedures for electronic and electrical items — Part 8 Vibration (sinusoidal) test

IS 9000 (Part 7/Sec 1) : 2006 Basic environmental testing procedures for electronic and electrical items — Part 7 Impact test, Section 1 Shock Test

IS 9001 (Part 1) : 1984 Guidance for environmental testing — Part 1 General

3 TERMINOLOGY

This clause of Part 1 is applicable except as follows.

3.1.7 Addition:

NOTE 101 The rated frequency is the input frequency.

3.1.9 Replacement:

Normal Operation — Operation of the appliance with $1\,000 \pm 50$ g of potable water at an initial temperature of $20 \pm 2^\circ\text{C}$ in a cylindrical borosilicate glass vessel having a maximum thickness of 3 mm and an outside diameter of approximately 190 mm. The vessel is placed on the centre of the shelf.

3.101 Microwave Oven — An appliance using electromagnetic energy in one or several of the ISM frequency bands between 300 MHz and 30 GHz, for heating food and beverages in a cavity.

NOTE — ISM frequency bands are the electromagnetic frequencies established by the ITU and reproduced in IS 6873 (Part 4).

3.102 Combination Microwave Oven — A microwave oven in which heat is also provided in the cavity by simultaneous or consecutive operation of resistive heating elements.

NOTE — The resistive heating elements are used to provide radiant heat, convection heat or steam.

3.103 Cavity — Space enclosed by the inner walls and the door in which the load is placed.

3.104 Shelf — Horizontal support in the cavity on which the load is placed.

3.105 Door Interlock — Device or system that prevents the operation of the magnetron, unless the oven door is closed.

3.106 Monitored Door Interlock — Door interlock system that incorporates a supervision device.

3.107 Temperature-Sensing Probe — Device that is inserted into the food to measure its temperature and is a part of an oven control.

3.107 Magnetron — Type of vacuum tube used to generate microwaves.

4 GENERAL REQUIREMENT

This clause of Part 1 is applicable.

5 GENERAL CONDITIONS FOR THE TESTS

This clause of Part 1 is applicable except as follows.

5.2 Addition:

NOTE 101 An additional sample may be required for the test of 19.104.

NOTE 102 Six samples of the interlocks are required for the test of 24.1.4.

5.3 Modification:

Instead of carrying out the tests in the order of clauses, the following sequence of clauses and subclauses applies: 32, 22.113, 22.108, 22.115, 22.116, 7 to 17, 20, 21 (except 21.101 to 21.105), 18, 19 (except 19.104) (except 22.108, 22.113, 22.115 and 22.116), 23 to 31, 21.101 to 21.105 and 19.104.

5.101 Microwave ovens are tested as motor-operated appliances.

5.102 Class III temperature-sensing probes are only subjected to the tests of 22.112.

6 CLASSIFICATION

This clause of Part 1 is applicable except as follows.

6.1 Modification:

Microwave ovens shall be Class I or Class II.

7 MARKING AND INSTRUCTIONS

This clause of Part 1 is applicable except as follows.

7.1 Addition:

Appliances shall be marked with the nominal frequency in megahertz of the ISM band in which they operate.

If the removal of any cover results in microwave leakage exceeding the value specified in 32, the cover shall be marked with the substance of the following:

WARNING
MICROWAVE ENERGY
DO NOT REMOVE THIS COVER

If an appliance incorporates a socket-outlet protected by means of fuses, other than D-type fuses, it shall be marked with the rated current of the relevant fuse. When a miniature fuse-link is provided, this marking shall indicate that the fuse-link is to have a high breaking capacity.

7.12 Addition:

The instructions shall state the substance of the following:

IMPORTANT SAFETY INSTRUCTIONS
READ CAREFULLY AND KEEP FOR FUTURE
REFERENCE

The instructions shall include the substance of the following warnings:

- a) **WARNING** — If the door or door seals are damaged, the oven must not be operated until it has been repaired by a competent person.
- b) **WARNING** — It is hazardous for anyone other than a competent person to carry out

any service or repair operation that involves the removal of a cover which gives protection against exposure to microwave energy.

- c) **WARNING** — Liquids and other foods must not be heated in sealed containers since they are liable to explode.

The instructions shall include the substance of the following:

- a) This appliance is intended to be used in household and similar applications such as:
- 1) Staff kitchen areas in shops, offices and other working environments;
 - 2) Farm houses;
 - 3) By clients in hotels, motels and other residential environments;
 - 4) Bed and breakfast type environments.

NOTE 101 If the manufacturer wishes to limit the use of the appliance to less than the above, this has to be clearly stated in the instructions.

- b) Minimum height of free space necessary above the top surface of the oven.
- c) Only use utensils that are suitable for use in microwave ovens.
- d) When heating food in plastic or paper containers, keep an eye on the oven due to the possibility of ignition.
- e) Microwave oven is intended for heating food and beverages. Drying of food or clothing and heating of warming pads, slippers, sponges, damp cloth and similar may lead to risk of injury, ignition or fire.
- f) If smoke is observed, switch off or unplug the appliance and keep the door closed in order to stifle any flames.
- g) Microwave heating of beverages can result in delayed eruptive boiling, therefore care must be taken when handling the container.
- h) Contents of feeding bottles and baby food jars shall be stirred or shaken and the temperature checked before consumption, in order to avoid burns.
- j) Eggs in their shell and whole hard-boiled eggs should not be heated in microwave ovens since they may explode, even after microwave heating has ended.
- k) Details for cleaning door seals, cavities and adjacent parts.
- m) Oven should be cleaned regularly and any food deposits removed.
- n) Failure to maintain the oven in a clean condition could lead to deterioration of the surface that could adversely affect the life of the appliance and possibly result in a

hazardous situation.

- p) Only use the temperature probe recommended for this oven (for appliances having a facility to use a temperature-sensing probe).

The manufacturer shall state in the instructions whether the microwave oven is intended to be used freestanding, built-in or in a cabinet. If the appliance can be used while placed in a cabinet,

- 1) the minimum dimensions of the cabinet shall be given by the manufacturer; and
- 2) the instructions shall state that the appliance must be operated with any cabinet door open.

The instructions for microwave ovens having an additional decorative door shall state that the appliance must be operated with the decorative door open.

The instructions for microwave ovens that are not tested in a cabinet shall state that the appliance must not be placed in a cabinet.

7.14 Addition:

The height of the lettering of the warning specified in 7.1 shall be at least 3 mm.

Compliance is checked by measurement.

8 PROTECTION AGAINST ACCESS TO LIVE PARTS

This clause of Part 1 is applicable except as follows.

8.1.1 Addition:

Test probe 18 of IS 1401 is also applied, as specified for test probe B. However, it is only applied to parts that are accessible when the oven is operated in normal use.

8.2 Addition:

Test probe 18 of IS 1401 is also applied, as specified for test probe B. However, it is only applied to parts that are accessible when the oven is operated in normal use.

9 STARTING OF MOTOR-OPERATED APPLIANCES

This clause of Part 1 is not applicable.

10 POWER INPUT AND CURRENT

This clause of Part 1 is applicable.

11 HEATING

This clause of Part 1 is applicable except as follows.

11.2 Addition:

Appliances, other than built-in appliances, are positioned as specified for heating appliances.

A ceiling is placed over the appliance at the minimum height stated in the instructions. The ceiling has a depth of 300 mm from the back wall of the test corner and a length at least 150 mm in excess of the width of the appliance.

Appliances that can be used when placed in a cabinet are placed in a cabinet with the minimum dimension given in the instructions by the manufacturer, the plywood specified for the test corner being used. The appliance is positioned against the rear wall and one of the side walls.

The cabinet door is in the open position.

11.7 Replacement:

Appliances are operated for three cycles, each cycle consisting of a heating period of 10 min followed by a rest period of 1 min. During the rest periods, the door is open and the load is replaced.

11.8 Addition:

The temperature rises of external surfaces of microwave ovens are only measured on the surfaces that are not placed against the wall and the floor of the test corner.

There are no temperature rise limits for air-outlet grilles and for surfaces up to a distance of 25 mm from them.

NOTE 101 These surfaces do not include handles.

12 VOID

13 LEAKAGE CURRENT AND ELECTRIC STRENGTH AT OPERATING TEMPERATURE

This clause of Part 1 is applicable.

14 TRANSIENT OVERVOLTAGES

This clause of Part 1 is applicable.

15 MOISTURE RESISTANCE

This clause of Part 1 is applicable except as follows.

15.2 Addition:

A quantity of 0.5 litre of water containing approximately 1 percent NaCl is poured steadily over the shelf over a period of 1 min. If the shelf can collect spilled liquid, it is filled with the saline solution and a further 0.5 l is then added over a period of 1 min.

15.101 Temperature-sensing probes shall be constructed so that their insulation is not affected by water.

Compliance is checked by the following test.

The probe is completely immersed in water containing approximately 1 percent NaCl and having a

temperature of $20 \pm 5^\circ\text{C}$. The water is heated to the boiling point in approximately 15 min. The probe is then removed from the boiling water and immersed in water having a temperature of $20 \pm 5^\circ\text{C}$ for 30 min.

This procedure is carried out five times, after which the probe is removed from the water. All traces of liquid are then removed from the surface.

The probe shall then withstand the leakage current test of **16.2**.

NOTE — Detachable temperature-sensing probes are not connected to the appliance for this test. Non-detachable temperature-sensing probes are tested in the oven, the probe being immersed as much as possible.

16 LEAKAGE CURRENT AND ELECTRIC STRENGTH

This clause of Part 1 is applicable except as follows.

16.101 The windings of the power transformer that supplies the magnetron shall have adequate insulation.

Compliance is checked by the test of **16.101.1** for switch-mode power supplies and by the test of **16.101.2** for other power transformers.

16.101.1 The insulation between the primary and secondary windings of switch-mode power supply transformers is subjected for 1 min to a voltage of substantially sinusoidal waveform and having a frequency of 50 Hz or 60 Hz. The value of the voltage is 1.414 times the peak value of the secondary working voltage plus 750 V, with a minimum of 1 250 V.

There shall be no breakdown between windings or between adjacent turns of the same winding.

16.101.2 Twice the working voltage is induced in the secondary winding of the transformer by applying a sinusoidal voltage having a frequency higher than rated frequency to the primary terminals.

The duration of the test is

- a) 60 s, for frequencies up to twice the rated frequency, or
- b) $120 \times \frac{\text{Rated frequency}}{\text{Test frequency}}$ s, with a minimum of 15 s, for higher frequencies.

A maximum of one-third of the test voltage is applied and is then rapidly increased without creating transients. At the end of the test, the voltage is decreased in a similar manner to approximately one-third of its full value before switching off.

There shall be no breakdown between windings or between adjacent turns of the same winding.

NOTE — The frequency of the test voltage is higher than the rated frequency to avoid excessive excitation current.

17 OVERLOAD PROTECTION OF TRANSFORMERS AND ASSOCIATED CIRCUITS

This clause of Part 1 is applicable except as follows.

Addition:

The tests are not carried out on the power transformer that supplies the magnetron and its associated circuits, these being checked during the tests of **19**.

18 ENDURANCE

This clause of Part 1 is replaced by the following.

The door system, including hinges, microwave seals and other associated parts, shall be constructed to withstand wear that may be expected in normal use.

Compliance is checked by the following test.

The door system is subjected to 50 000 cycles of operation with the appliance supplied at rated voltage and containing an appropriate microwave-absorbing load. It is then subjected to 50 000 cycles of operation without microwave generation.

The door is opened and closed as in normal use. It is opened from the closed position to a position approximately 10° before fully open. The rate of operation is 6 cycles/min. With the agreement of the manufacturer, the rate of operation without microwave generation can be increased to 12 cycles/min.

After the test, the microwave leakage shall not exceed the limit specified in **32** and the door system shall still function.

NOTE **101** Controls may be rendered inoperative in order to carry out the test.

NOTE **102** Components, the deterioration of which does not impair compliance with this standard, may be replaced in order to complete the test.

NOTE **103** Bricks or additional water of maximum 500 g may be added, if necessary to avoid stopping of the test due to overheating.

19 ABNORMAL OPERATION

This clause of Part 1 is applicable except as follows.

19.1 Modification:

Instead of subjecting the appliance to the tests of **19.2** to **19.10**, compliance is checked by the tests of **19.101** to **19.105**, the appliance being supplied at rated voltage.

19.11.2 Addition:

The cathode-to-anode circuit of the magnetron is open-circuited and short-circuited in turn. If one of these fault conditions results in an input current that increases with decreasing voltage, the test is carried out with the appliance supplied at 0.94 times rated voltage.

However, if the input current increases more than proportionally with voltage, the appliance is supplied at 1.06 times rated voltage.

The filament of the magnetron is not short-circuited.

19.13 Addition:

The temperature of windings shall not exceed the values shown in Table 8. Only appliances that allow a pre-selected start time and those operating with a keep-warm function are considered to be appliances operated until steady conditions are established.

During the tests, the microwave leakage shall not exceed 100 W/m² measured in accordance with **32** but with the load as specified for each sub-clause. The appliance shall comply with **32** if it can be operated after the tests.

19.101 Appliances are operated with controls set at the most unfavourable position and without load in the cavity.

The period of operation is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

19.102 Appliances are operated under normal operation with the timer or other controls that operate in normal use short-circuited.

NOTE — If the appliance is provided with more than one control, these are short-circuited in turn.

19.103 Appliances are operated under normal operation and with any single fault condition simulated that is likely to occur. The controls are adjusted to their most unfavourable setting and the appliance is operated for the maximum time allowed by the timer or 90 min, whichever is shorter.

NOTE — Examples of fault conditions are,

- a) blocking of air openings in the same plane. This fault condition is not applied if the appliance is a built-in appliance;
- b) locking the rotor of motors if the locked rotor torque is smaller than the full load torque; and
- c) locking moving parts liable to be jammed.

19.104 The appliance is operated with the controls adjusted to their most unfavourable setting and with a potato placed on the shelf in the position where it is most likely to ignite and propagate flames to other combustible material.

The potato has an approximately ellipsoidal shape and a mass between 125 g and 150 g. The length of the shortest principal axis is at least 40 mm. The length of the longest principal axis is not more than 140 mm and may be symmetrically reduced in order to obtain the specified mass. A steel wire, having a diameter of 1.5 ± 0.5 mm and approximately the same length as the

longest axis of the potato, is inserted along this axis.

The test is terminated 15 min after the microwave generation has ceased or a fire in the cavity has extinguished.

During the test, any fire in the cavity shall be contained within the appliance.

NOTE 1 **19.13** does not apply during the test.

After the test, if the appliance is still operable, any damaged detachable shelf is replaced and **19.13** applies. If the appliance does not comply, the test is repeated on a new appliance.

NOTE 2 Non-compliance may have resulted from the cumulative effects of previous tests.

19.105 Built-in appliances having an additional decorative door and appliances to be used in a cabinet are operated under normal operation but with the decorative door or cabinet door closed.

The period of operation is the maximum time allowed by the timer or until steady conditions are established, whichever is shorter.

20 STABILITY AND MECHANICAL HAZARDS

This clause of Part 1 is applicable except as follows.

20.101 Appliances having doors with a horizontal hinge at their lower edge and on which a load is likely to be placed shall have adequate stability.

Compliance is checked by the following test.

The appliance is placed on a horizontal surface with the door open and a mass is gently placed on the geometric centre of the door.

The mass is,

- a) 7 kg for stationary appliances; and
- b) 3.5 kg for portable appliances.

NOTE — A sandbag may be used for the load.

The appliance shall not tilt.

21 MECHANICAL STRENGTH

This clause of Part 1 is applicable except as follows.

Addition:

Compliance is also checked by the tests of **21.101** to **21.105**.

21.101 Hinged doors are positioned approximately 30° before the fully open position. Sliding doors are positioned so that they are approximately two-thirds open. A force of 35 N is applied to the inside surface of a hinged door at a point 25 mm from its free edge or to the handle of a sliding door.

The force is applied by means of a spring balance having a spring constant of 1.05 N/mm. It is initially applied with an opposing force applied to the other side of the door or handle. The opposing force is then removed to allow the door to complete its travel to the fully open position.

The test is carried out five times.

The test is repeated on doors of stationary appliances and built-in appliances except that,

- a) the door is initially placed midway between the fully open and closed positions; and
- b) the applied force is 1.5 times the force required to open the door or 65 N, whichever is greater. However if the force cannot be measured or if the door is opened indirectly, the 65 N force is applied.

The test is carried out five times.

Doors are placed midway between the fully open and closed positions. A closing force of 90 N is applied to the outside surface of a hinged door at a point 25 mm from the free edge or to the handle of a sliding door, initially with the opposing force as described above.

This test is carried out 10 times.

The appliance shall then comply with **32**.

21.102 Side-hinged doors are placed in the fully open position. A downward force of 140 N or the maximum force that can be applied in any door position without tilting the appliance, whichever is smaller, is then applied to the free edge of the door and the door is closed. The door is fully opened again with the force still applied.

This test is carried out five times.

Bottom-hinged doors are opened. A force of 140 N or the maximum force that can be applied without tilting the appliance, whichever is smaller, is applied to the inside surface of the door at the most unfavourable position 25 mm from the free edge.

The force is applied for 15 min.

The appliance shall then comply with **32**.

21.103 A cube of wood having a side dimension of 20 mm is attached to an inside corner farthest from the door hinge. An attempt is made to close the door with a force of 90 N applied at the other corner farthest from the hinge in the direction perpendicular to the surface of the door.

The force is maintained for 5 s.

The cube is then removed. The door is slowly closed until microwave generation becomes possible. The

door and its opening means are then manipulated in order to determine the position resulting in the highest microwave leakage.

The appliance shall then comply with **32**.

The test is repeated with the wooden cube attached to the other corner farthest from the hinge.

NOTE — The test is not applicable to sliding doors.

21.104 The door is closed and its outside surface subjected to three impacts, each having an energy of 3 J. These impacts are applied to the central part of the door and may be at the same point.

The impact is applied by means of a steel ball having a diameter of 50 mm and a mass of approximately 0.5 kg. The ball is suspended by a suitable cord that is held in the plane of the door. The ball is allowed to fall as a pendulum through the distance required to strike the surface with the specified impact energy.

The door is then opened and its mating surface on the oven is subjected to three similar impacts.

The inside surface of a hinged door is subjected to three impacts as before, the test being made with the door in the fully open position. The impacts are applied to the central part of the door and may be at the same point. However, if a bottom-hinged door is horizontal when in the fully open position, the impacts are applied by allowing the steel ball to fall freely through a distance such that the specified impact energy is obtained.

A bottom-hinged door is further tested by subjecting its seal to three similar impacts. The impacts are made at three different locations.

The appliance shall then comply with **32**.

21.105 A bottom-hinged door is opened and a hardwood dowel having a diameter of 10 mm and a length of 300 mm is placed along the bottom hinge. The dowel is positioned such that one end is flush with an outside edge of the door. A closing force of 90 N is applied to the centre of the handle in a direction perpendicular to the surface of the door. The force is maintained for 5 s.

The test is repeated with the end of the dowel flush with the other outside edge and then with the dowel positioned centrally within the door hinge.

The microwave leakage is measured under the conditions specified in **32**, and shall not exceed 100 W/m².

22 CONSTRUCTION

This clause of Part 1 is applicable except as follows.

22.101 Built-in appliances shall only be vented through the front, unless provisions are made for venting through a duct.

Compliance is checked by inspection.

22.102 Oven vents shall be constructed so that any moisture or grease discharged through them cannot affect creepage distances and clearances between live parts and other parts of the appliance.

Compliance is checked by inspection.

22.103 The appliances shall be constructed in compliance with either **22.103.1** or **22.103.2**.

22.103.1 Appliances shall incorporate at least two door interlocks that are operated by opening the door, one being a monitored door interlock. At least one of the door interlocks shall be concealed and not operable by manipulation.

Compliance is checked by inspection and concealment is checked by **22.105**.

NOTE — The two door interlocks may be incorporated in the system of the monitored door interlock.

22.103.2 Appliances shall incorporate two independent monitored door interlocks that are operated by opening the door. In this case, **22.105** is not applicable.

NOTE — None of the door interlocks have to be concealed because there are two independent monitored door interlocks incorporating supervision devices.

Compliance is checked by inspection and the following test.

The door is slowly opened and, simultaneously, an attempt is made to manually defeat any accessible door interlock by test probe B one at a time.

During the tests, the operation of the magnetron shall not be possible.

22.104 At least one door interlock of **22.103.1** and both monitored door interlocks of **22.103.2** shall incorporate a switch that disconnects the microwave generator or its supply main circuit.

Compliance is checked by inspection.

22.105 At least one of the door interlocks shall be concealed and not operable by manipulation. This door interlock shall operate before any accessible door interlock can be defeated.

Compliance is checked by the following test.

The door is placed in the open or closed position and an attempt is made to operate the concealed door interlock by applying test probe B of IS 1401 to all openings. The test is repeated with a rod, as shown in Fig. 101, to any openings of the door interlock mechanism. Only one rod shall be used at a time.

Door interlocks that operate magnetically are also evaluated by applying a magnet to the enclosure over

the door interlock switch. The magnet has a similar configuration and magnetic orientation to the magnets that operate the door interlock. It shall be capable of exerting a force of 50 ± 5 N when applied to a mild steel armature having dimensions of $80 \text{ mm} \times 50 \text{ mm} \times 8 \text{ mm}$. In addition, the magnet shall be capable of applying a force of 5 ± 0.5 N at a distance of 10 mm from the armature.

The door is slowly opened and, simultaneously, an attempt is made to manually defeat any accessible door interlock with test probe B, the rod and the magnet.

It shall not be possible to operate the concealed door interlock during the tests.

22.106 The supervision device of each monitored door interlock shall render the appliance inoperable, if its switching part fails to control the microwave generator.

Compliance is checked by the following test.

The switching part of the monitored door interlock is rendered inoperative. The appliance is supplied at rated voltage from a supply source having a short-circuit capacity of at least 1.5 kA for appliances having a rated voltage over 150 V and 1.0 kA for other appliances.

The appliance is operated with the door closed and an attempt is then made to gain access to the cavity in the normal way. It shall not be possible to open the door, unless the microwave generator ceases to function and remains inoperative. The supervision device shall not fail in the open-circuit position.

NOTE 1 The supervision device is replaced for subsequent tests if it fails in the closed-circuit position.

NOTE 2 It may be necessary to render other door interlocks inoperative in order to perform this test.

If an internal fuse in the circuit supplying the microwave generator ruptures, the fuse is replaced and the test is carried out two more times. The internal fuse shall rupture each time.

The test is carried out three more times but with an impedance of $(0.4 + j 0.25) \Omega$ in series with the supply source. The internal fuse shall rupture each time.

NOTE 3 For appliances having a rated voltage under 150 V and those with a rated current over 16 A, the test with the series impedance is not carried out.

22.107 The failure of any single electrical or mechanical component that affects the operation of a door interlock shall not cause any other door interlock, or the supervision device of the monitored door interlock to become inoperative, unless the appliance is rendered inoperable.

Compliance is checked by inspection and, if necessary, by simulating component failure and operating the appliance as in normal use.

NOTE — This requirement does not apply to components of the supervision device that comply with the test of **22.106**.

22.108 The door interlocks incorporated to comply with **22.103** shall operate before undue microwave leakage occurs.

Compliance is checked by the following test.

All door interlocks except one are rendered inoperative. The appliance is supplied at rated voltage and operated with the load specified in **32**. The door opening sequence is carried out in small increments during which the microwave leakage is measured.

The appliance shall comply with **32**.

The test is repeated on each door interlock in turn.

NOTES

- 1 Door interlocks are only tested if they are necessary for compliance with **22.103**.
- 2 It may be necessary to render the supervision device of the monitored door interlock inoperative when carrying out the test.

22.109 There shall be no undue microwave leakage, if thin material is introduced between the door and its mating surface.

Compliance is checked by closing the door on a strip of paper having a width of 60 ± 5 mm and a thickness of 0.15 ± 0.05 mm, the paper being placed between the door and its mating surface.

The appliance shall then comply with **32**.

The test is carried out 10 times with the paper in different locations.

22.110 There shall be no undue microwave leakage, if the door seals become contaminated by food residues.

Compliance is checked by the following test.

The door seal is coated with cooking oil. If the seal has an open choke, the trough is filled with oil.

The appliance shall then comply with **32**.

22.111 There shall be no undue microwave leakage when the door corners are subjected to distortion.

Compliance is checked by the following test.

The appliance is supplied at rated voltage and operated with the load specified in **32**. The door and its opening means are manipulated until the largest door gap permitting microwave generation is obtained. A pull force is applied perpendicular to the surface of the door to each corner in turn. The force is slowly increased to 40 N.

During the test, the microwave leakage is measured under the conditions specified in **32** and shall not exceed 100 W/m^2 .

After the test, the appliance shall comply with **32**.

22.112 There shall be no undue microwave leakage, and the temperature-sensing probe shall not become damaged when a probe or its cord is trapped by the door.

Compliance is checked by the following test.

The probe is connected as in normal use, the sensing part or cord being allowed to rest in the most unfavourable position likely to occur. The door is closed against the sensing part or the cord with a force of 90 N applied for 5 s in the most unfavourable place. The force is then released and, if the oven can be operated, the microwave leakage is measured under the conditions specified in **32** and shall not exceed 100 W/m².

After the test, the appliance shall comply with **32** and the temperature-sensing probe shall comply with **8.1**, **15.101** and **29**.

22.113 There shall be no undue microwave leakage when detachable parts are removed.

Compliance is checked by the following test.

Detachable parts are removed, except shelves, unless a horizontal surface greater than 85 mm in diameter is made available when they are removed.

The appliance shall then comply with **32**, the load being placed on the horizontal surface as close as possible to the centre of the cavity.

NOTE — In order to avoid detecting non-radiating standing waves, the tip of the instrument probe is not inserted into an opening resulting from the removal of a detachable part.

22.114 A single fault such as failure of basic insulation or a loose wire bridging the insulation system shall not allow operation of the microwave generator with the door open.

Compliance is checked by inspection and if, necessary, by simulating relevant faults. Wires that may become loose are disconnected and allowed to fall out of position but are not otherwise manipulated. They shall not come into contact with other live parts or earthed parts if this results in all door interlocks becoming inoperative.

NOTE 1 Failure of reinforced insulation or double insulation is considered to be two faults.

NOTE 2 Wires secured by two independent fixings are not considered likely to become loose.

22.115 There shall be no access to the cavity through the viewing screen.

Compliance is checked by inspection and the following test.

A straight steel rod having a diameter of 1 mm and a

flat end is pressed perpendicularly against the viewing screen with a force of 2 N. The rod shall not enter the cavity.

22.116 Appliances for installing in road vehicles, caravans and similar vehicles shall withstand the vibrations to which they may be subjected.

Compliance is checked by carrying out the vibration tests specified in IS 9000 (Part 8) under the following conditions.

The appliance is fastened in its normal position of use to a vibration-generator by means of straps around the enclosure. The type of vibration is sinusoidal, and the severity is as follows:

- a) Direction of vibration is vertical;
- b) Amplitude of vibration is 0.35 mm;
- c) Sweep frequency range is 10 Hz to 55 Hz; and
- d) Duration of the test is 30 min.

The appliance shall show no damage that could impair compliance with **8.1**, **16.3**, **29** and **32** and connections shall not have worked loose.

22.117 If electronic circuits are used to provide protection against microwave leakage they shall be designed so that a fault condition shall not affect protection against microwave leakage.

Compliance is checked by applying the tests in **19** in conjunction with the requirements and test specifications in **22.105**, **22.106**, **22.107** and **22.108**.

23 INTERNAL WIRING

This clause of Part 1 is applicable.

24 COMPONENTS

This clause of Part 1 is applicable except as follows.

24.1.4 Addition:

Interlocks are subjected to the following test which is carried out on six samples.

The interlocks are connected to a load that simulates the conditions occurring in the appliance when it is supplied at rated voltage. They are operated at a rate of approximately six cycles/min. The number of cycles is:

- a) Door interlocks : 50 000
- b) Interlocks only operated during user maintenance : 5 000

After the test, the interlocks shall not be damaged to such an extent that their further use is impaired.

24.101 Socket-outlets incorporated in appliances shall be single-phase, incorporate an earthing contact and

have a rated current not exceeding 16 A. Both poles shall be protected by fuses or miniature circuit-breakers placed behind a non-detachable cover and having a rated current not exceeding

- a) 20 A, for appliances having a rated voltage up to 130 V; and
- b) 10 A, for other appliances.

If the appliance is intended to be permanently connected to fixed wiring, or is fitted with a polarized plug, the neutral pole need not be protected.

Compliance is checked by inspection.

NOTE — The actuating member of miniature circuit-breakers may be accessible.

25 SUPPLY CONNECTION AND EXTERNAL FLEXIBLE CORDS

This clause of Part 1 is applicable except as follows.

25.14 Addition:

For temperature-sensing probes, the total number of flexings is 5 000. Probes with circular-section cords are turned through 90° after 2 500 flexings.

26 TERMINALS FOR EXTERNAL CONDUCTORS

This clause of Part 1 is applicable.

27 PROVISION FOR EARTHING

This clause of Part 1 is applicable.

28 SCREWS AND CONNECTIONS

This clause of Part 1 is applicable.

29 CLEARANCES, CREEPAGE DISTANCES AND SOLID INSULATION

This clause of Part 1 is applicable.

30 RESISTANCE TO HEAT AND FIRE

This clause of Part 1 is applicable except as follows.

30.2 Addition:

For appliances that allow a pre-selected start time and

those with a keep-warm function, 30.2.3 is applicable. For other appliances, 30.2.2 is applicable.

31 RESISTANCE TO RUSTING

This clause of Part 1 is applicable.

32 RADIATION, TOXICITY AND SIMILAR HAZARDS

This clause of Part 1 is applicable except as follows.

Addition:

Compliance for microwave leakage is checked by the following test.

A load of 275 ± 15 g of potable water having a temperature of $20 \pm 2^\circ\text{C}$, in a thin-wall borosilicate glass vessel having an inside diameter of approximately 85 mm, is placed on the centre of the shelf. The appliance is supplied at rated voltage and operated with the microwave power control at the highest setting.

Microwave leakage is determined by measuring the microwave flux density using an instrument that reaches 90 percent of its steady reading in 2 s to 3 s when subjected to a stepped input signal. The instrument antenna is moved over the external surface of the appliance to locate the highest microwave leakage, particular attention being given to the door and its seals.

The microwave leakage at any point 50 mm or more from the external surface of the appliance shall not exceed 50 W/m^2 .

NOTE 101 If compliance with the test is in doubt due to a high water temperature, the test is repeated with a fresh load.

101 TESTS

101.1 Type Tests

The tests specified in Table 101 shall constitute the type tests and shall be carried out on a sample selected preferably at random from regular production lot. Before commencement of the tests, the appliance shall be visually examined and inspected for obvious visual defects in respect of components, parts and their assembly, construction, mechanical hazards, marking,

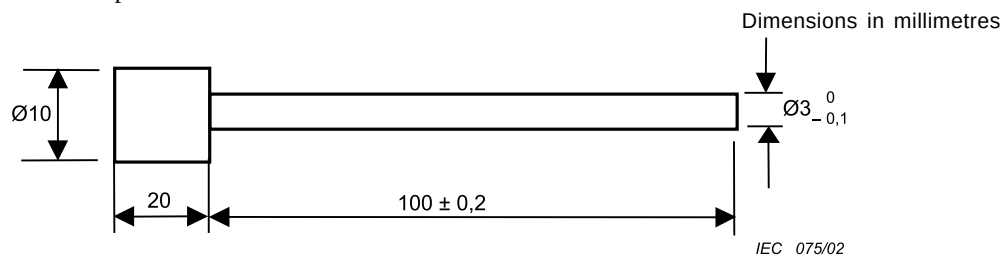


FIGURE 101 – TEST ROD FOR INTERLOCK CONCEALMENT

provision of suitable terminals for supply connections, earthing and the effectiveness of screws and connections. The external surface finish shall be even and free from finishing defects.

NOTE — Additional samples may be required for some tests, as mentioned in specific clauses..

Table 101 Schedule of Type Tests
(Clause 101.1)

Sl No.	Tests	Ref to Clause
(1)	(2)	(3)
i)	Protection against access to live parts	8
ii)	Starting of motor-operated appliances	9
iii)	Power input and current	10
iv)	Heating	11
v)	Leakage current and electric strength at operating temperature	13
vi)	Transient overvoltages	14
vii)	Moisture resistance	15
viii)	Leakage current and electric strength	16
ix)	Overload protection of transformers and associated circuits	17
x)	Endurance	18
xi)	Abnormal operation	19
xii)	Stability and mechanical hazards	20
xiii)	Mechanical Strength	21
xiv)	Construction	22
xv)	Internal wiring	23
xvi)	Components	24
xvii)	Supply connection and external flexible cords	25
xviii)	Terminals for external conductors	26
xix)	Provision for earthing	27
xx)	Screw and connections	28
xxi)	Clearances, creepage distances and solid insulation	29
xxii)	Resistance to heat and fire	30
xxiii)	Resistance to rusting	31
xxiv)	Radiation, toxicity and similar hazards	32

101.1.1 Criteria of Acceptance

Sample shall successfully pass all the type tests for proving conformity with the requirements of the standard. If the sample fails in any of the type tests, the testing authority, at its discretion, may call for fresh samples not exceeding twice the original number and subject them again to all tests or to the test (s) in which failure (s) had occurred. No failure should be permitted in the repeat tests (s).

101.2 Acceptance Tests

The following shall constitute the acceptance tests:

Sl No.	Tests	Ref to Clause
(1)	(2)	(3)
i)	Protection against access to live parts	8
ii)	Starting of motor operated appliances	9
iii)	Power input and current	10
iv)	Heating	11
v)	Leakage current and electric strength at operating temperature	13
vi)	Moisture resistance	15
vii)	Leakage current and electric strength	16
viii)	Provision for earthing	27

NOTE — For the purpose of acceptance tests, the humidity treatment shall be done for 24 h while conducting the test for moisture resistance (*see 15*)

101.2.1 A recommended sampling procedure for acceptance tests is given in Annex J of IS 302-1.

ANNEXES

The annexes of Part 1 are applicable except as follows.

ANNEX A

(Clause 5.1)

ROUTINE TESTS

This annex of Part 1 is applicable except as follows.

A-2 ELECTRIC STRENGTH TEST

Modification:

The current in the test circuit may be increased up to 100 mA.

A-101 MARKING AND INSTRUCTIONS

The covers are checked to ensure that they are marked with the warnings concerning microwave energy.

The appliance is checked to ensure that the corresponding instructions are provided with it.

A-102 CONSTRUCTION

The operation of the door interlock system is checked

to ensure that microwave generation ceases when the door is opened.

A-103 MICROWAVE LEAKAGE

The microwave oven is supplied at rated voltage and operated with the microwave power control adjusted to the highest setting. The energy flux density of microwave leakage is measured at any point approximately 50 mm from the external surface of the appliance. An appropriate load may be used. The measuring instrument is moved over the external surface of the oven and the microwave leakage measured.

The microwave leakage shall not exceed 50 W/m².

ANNEX AA

(Clause 5.101)

COMBINATION MICROWAVE OVENS

The following modifications to this standard are applicable for combination microwave ovens.

For stationary combination microwave ovens, IS 303-2-6 is also applicable. For portable combination microwave ovens, IS 302-2-9 is also applicable. However, the requirements of these standards do not take precedence over this standard.

NOTE — If a combination microwave oven has a mode of operation independent of microwave generation, then this mode has to be tested only according to the requirements in the relevant standard. If a combination microwave oven has a mode of operations without the use of resistive heating elements, it is tested to comply with the relevant requirements of this standard.

3 TERMS AND DEFINITIONS

3.1.9 Addition:

The appliance is operated with the controls adjusted to the most unfavourable setting in accordance with the instructions for the intended mode of operation.

5 GENERAL CONDITIONS FOR THE TESTS

5.3 Addition:

NOTE 101 When testing the different modes of operation, only those tests having the most unfavourable conditions are carried out.

5.101 Addition:

Combination microwave ovens are tested as combined appliances.

7 MARKING AND INSTRUCTIONS**7.12 Addition:**

The instructions for use shall also include the substance of the following.

WARNING — When the appliance is operated in the combination mode, children should only use the oven under adult supervision due to the temperatures generated.

11 HEATING**11.7 Replacement:**

Microwave ovens having a grill that can be operated simultaneously with microwave generation are operated for 30 min, the microwave power output being approximately 50 percent.

Microwave ovens having convection heating that can be operated simultaneously with microwave generation are operated for 60 min, the microwave power output being approximately 50 percent.

Microwave ovens having a grill or convection heating that can be operated sequentially with microwave generation are operated for 15 min with the microwave power output control adjusted to the highest setting, followed by 30 min of operation without microwave generation.

If more than half the water evaporates during the test, the vessel is refilled with boiling water, the door not being opened for more than 10 s.

NOTE 101 These tests are considered to cover appliances having programmers or timers.

11.8 Addition:

NOTE 101 When combination microwave ovens are operated under the combination mode, the limit values in IS 302-2-6 should be applied for stationary appliances and the limit values in IS 302-2-9 should be applied for portable appliances.

18 ENDURANCE**Addition:**

Before measuring the microwave leakage, the following additional conditioning is carried out,

- a) resistive heating elements for radiant heating are operated for 15 min;
- b) resistive heating elements for convection heating are operated for 30 min; and
- c) pyrolytic self-cleaning ovens are operated for one cleaning cycle.

19 ABNORMAL OPERATION**19.1 Modification:**

The test of **19.102** is carried out with the appliance supplied at 1.06 times rated voltage.

29 CLEARANCES, CREEPAGE DISTANCES AND SOLID INSULATION**Replacement:**

This clause of Part 1 is applicable except as follows.

29.2 Addition to the Second Paragraph:

- c) the insulation is exposed to exhaust air from the oven cavity, in which case pollution degree 3 applies.

29.3 Addition:

There are no thickness requirements for sheaths of visibly glowing heating elements, if the door interlocks provide all-pole disconnection.

ANNEX BB

(Clause 1)

MICROWAVE OVENS INTENDED TO BE USED ON BOARD SHIPS

The following modifications to this standard are applicable for microwave ovens intended to be used on board ships.

3 TERMS AND DEFINITIONS

3.BB.101 Open Deck — Area that is exposed to marine environment.

3.BB.102 Day Room — Area that may be exposed to marine environment from time to time

6 CLASSIFICATION

6.2 Addition:

Appliances for open deck use shall be IPX6.

7 MARKING AND INSTRUCTIONS

7.12 Addition:

The instructions for use shall also include the substance of the following.

- a) usage on board ships;
- b) installation place (open deck protective enclosure, dayrooms);
- c) fastening means.

22 CONSTRUCTION

22.BB.101 Appliances shall withstand the pulses to which they may be subjected.

Compliance is checked by carrying out the half-sine pulse tests specified in IS 9000 (Part 7/Sec 1) under the following conditions.

The appliance is fastened in its normal position of use to a shock-testing machine by means of straps around the enclosure.

The type of pulse is a half-sine pulse and the severity is as follows:

- a) Application of the half-sine pulse is in all 3 axes;
- b) Peak acceleration: 250 m/s²,
- c) Duration of each half-sine pulse: 6 ms;
- d) Number of half-sine pulses in each direction: 1 000 ± 10.

The appliance shall show no damage that could impair compliance with **8.1**, **16.3**, **29** and **32**, and connections shall not have worked loose.

22.BB.102 Appliances shall withstand the vibrations to which they may be subjected.

Compliance is checked by carrying out the vibration tests specified in IS 9000 (Part 8) under the following conditions.

The appliance is fastened in its normal position of use upon a vibration table by means of straps around the enclosure. The type of vibration is sinusoidal and the severity is as follows:

- a) Direction of vibration is vertical and horizontal;
- b) Amplitude of vibration: 0.35 mm;
- c) Sweep frequency range: 10 Hz to 150 Hz;
- d) Duration of the test: 30 min.

The appliance shall show no damage that could impair compliance with **8.1**, **16.3**, **29** and **32**, and connections shall not have worked loose.

31 RESISTANCE TO RUSTING

Replacement:

This clause of Part 1 is applicable except as follows.

Addition:

Compliance is checked by the salt mist test Kb as given at Annex CC,

- a) for 'open deck' use severity 1 is applicable;
- b) for 'dayrooms' use severity 2 is applicable.

Before the test, coatings are scratched by means a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of 0.25 ± 0.02 mm. The pin is loaded so that the force exerted along its axis is 10 ± 0.5 N. The scratches are made by drawing the pin along the surface of the coating at the speed of approximately 20 mm/s. Five scratches are made at least 5 mm apart and at least 5 mm from the edges.

After the test, the appliance shall not have deteriorated to such an extent that compliance with this standard, in particular with **8** and **27**, is impaired. The coating shall not be broken and shall not have detached from the metal surface.

ANNEX CC

(Clause 31 (Annex BB))

**ENVIRONMENTAL TESTING – TEST Kb: SALT MIST, CYCLIC
(SODIUM CHLORIDE SOLUTION)****CC-1 INTRODUCTION**

This test is intended for application to components or equipment designed to withstand a salt-laden atmosphere, depending on the chosen severity. Salt can degrade the performance of parts manufactured using metallic and/or non-metallic materials.

The mechanism of salt corrosion on metallic materials is electrochemical, whereas the degradation effects experienced on non-metallic materials are caused by complex chemical reactions of the salts with the materials involved. The rate at which corrosive action takes place is dependent, to a large extent, on the supply of oxygenated salt solution to the surface of the test specimen, the temperature of the specimen and the temperature and humidity of the environment.

Apart from the corrosive effects, this test may be used to indicate deterioration of some non-metallic materials by assimilation of salts. In the following test methods, the period of spraying with the relevant salt solution is sufficient to wet the specimen thoroughly.

Because this wetting is repeated after intervals of storage under humid conditions [severities (1) and (2) and - in some cases severities (3) to (6)] - supplemented by storage under a standard atmosphere for testing, it goes some way to reproducing the effects of natural environments.

Severities (1) and (2) are intended to be used for testing products which are used in a marine environment, or in close proximity to the sea. Severity (1) should be used to test products which are exposed to the environment for much of their operational life (for example ship radar, deck equipment). Severity (2) should be used to test products which may be exposed to the marine environment from time to time but will normally be protected by an enclosure (for example navigational equipment which will normally be used on the bridge or in a control room).

Additionally, severities (1) and (2) are commonly used as a general corrosion test in component quality assurance procedures.

Severities (3) to (6) are intended for products where, under normal use, there is a frequent change between salt-laden and dry atmosphere, for example automobiles and their parts.

Severities (3) to (6), compared to severities (1) and (2), therefore include an additional storage under a standard atmosphere for testing.

The period of dry atmosphere may happen, in practice, during breaks of operation, for example during the weekend. This inclusion of such a dry period in severities (3) to (6) leads to corrosion mechanism which can be quite different from those under constant humid conditions.

CC-2 GENERAL DESCRIPTION OF THE TEST

For severities (1) and (2), the test procedure is separated into a specified number of periods of spraying by a salt mist at a temperature between 15°C and 35°C, each followed by a storage period under humid conditions at $40 \pm 2^\circ\text{C}$, 93+3 percent relative humidity.

For severities (3), (4), (5) and (6) the test procedure is separated into a specified number of test cycles. Each test cycle consists of four periods of spraying by a salt mist at a temperature between 15°C and 35°C, each followed by a storage period under humid conditions at $40 \pm 2^\circ\text{C}$, (93) percent relative humidity, and of one storage period under a standard atmosphere for testing at $23 \pm 2^\circ\text{C}$ and 45 percent to 55 percent relative humidity after these four periods of spraying and storage under humid conditions.

If the spray period and storage period are carried out in different chambers, care should be taken to avoid loss of salt solution deposits on the specimen and to avoid any damage to the specimen due to handling.

The specimen is never energized during the spray period, and not normally during the storage period.

CC-3 TEST APPARATUS**CC-3.1 Salt Mist Chamber**

The chamber for this test shall be constructed of such materials that will not influence the corrosive effects of the salt mist.

The detailed construction of the chamber, including the method of producing the salt mist is optional, provided that,

- a) the conditions in the chamber are within the limits specified;
- b) a sufficiently large volume with constant, homogeneous conditions (not affected by turbulence) is available; these conditions should not be influenced by the specimen under test;

- c) no direct spray impinges upon the specimen under test;
- d) drops of liquid accumulating on the ceiling, the walls, or other parts cannot drip on the specimen; and
- e) the chamber shall be properly vented to prevent pressure build-up and allow uniform distribution of the salt mist. The discharge end of the vent shall be protected from strong draughts which can cause strong air currents in the chamber.

CC-3.1.1 Atomizer(s)

The atomizer(s) shall be of such a design and construction as to produce a finely divided, wet, dense mist. The atomizer(s) shall be made of material that is non-reactive to the salt solution.

CC-3.1.2 The sprayed solution shall not be re-used.

CC-3.1.3 Air Supply

If use is made of compressed air, that air shall, when entering the atomizer(s), be essentially free from all impurities, such as oil and dust.

Means shall be provided to humidify the compressed air as required to meet the operating conditions. The air pressure shall be suitable to produce a finely divided dense mist with the atomizer(s) used.

To ensure against clogging of the atomizer(s) by salt deposition, the air is recommended to have a relative humidity of at least 85 percent at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing water, which should be automatically maintained at a constant level. The temperature of this water shall be not less than that of the chamber.

The air pressure shall be capable of adjustment so that the collection rate as specified in **9.2** can be maintained.

CC-3.2 Humidity Chamber

The chamber shall conform to the requirements of IS 9000 (Part 4), and, it shall maintain a humidity of 93 ± 3 percent at a temperature of $40 \pm 2^\circ\text{C}$.

CC-3.3 Chamber for Standard Atmosphere

The chamber shall maintain a humidity of 45 percent to 55 percent at a temperature of $23 \pm 2^\circ\text{C}$.

CC-4 SALT SOLUTION

CC-4.1 5 percent Sodium Chloride (NaCl) Solution

CC-4.1.1 The salt used for the test shall be high-quality sodium chloride (NaCl) containing, when dry, not more than 0.1 percent sodium iodide and not more than 0.3 percent of total impurities.

The salt solution concentration shall be 5 ± 1 percent by weight.

The solution shall be prepared by dissolving 5 ± 1 parts by weight of salt in 95 parts by weight of distilled or demineralized water.

NOTE — The relevant specification may call for other salt solutions, the composition and characteristics (density, pH value, etc) of which should be stated clearly in the specification, e.g. to simulate the special effects of a marine environment.

CC-4.1.2 The pH value of the solution shall be between 6.5 and 7.2 at a temperature of $20 \pm 2^\circ\text{C}$. The pH value shall be maintained within this range during conditioning; for this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.

CC-5 SEVERITIES

CC-5.1 The severity of the test is defined as follows.

- a) For severities (1) and (2):' by the combination of the number of spray periods and the duration of the storage under humid conditions following each spray period.
- b) For severities (3) to (6):' by the number of test cycles consisting of four spraying periods with storage under humid conditions after each one, and one additional storage period under a standard atmosphere for testing after these four periods of spraying and storage under humid conditions.

CC-5.2 The relevant specification shall indicate which of the six following severities shall be used.

Severity (1), four spray periods, each of 2 h, with a humidity storage period of seven days after each.

NOTE — The humidity storage period should be suitably reduced so that the spray period plus storage period is seven days.

Severity (2), three spray periods, each of 2 h, with a humidity storage period between 20 h and 22 h after each.

Severity (3), one test cycle consisting of:

four spray periods, each of 2 h, with a humidity storage period between 20 h and 22 h after each; afterwards one storage period of three days under a standard atmosphere for testing at $23 \pm 2^\circ\text{C}$ and 45 percent to 55 percent humidity.

Severity (4), two test cycles as specified in severity (3).

Severity (5), four test cycles as specified in severity (3).

Severity (6), eight test cycles as specified in severity (3).

CC-5.3 A schematic survey of time-scale of all the test severities is given in Fig CC-1.

CC-6 INITIAL MEASUREMENTS

The test specimen shall be visually inspected and, if necessary, electrically and mechanically checked as required by the relevant specification.

CC-7 PRE-CONDITIONING

The relevant specification shall prescribe the cleaning procedure to be applied immediately before the test; it shall also state whether temporary protective coatings shall be removed.

NOTE — The cleaning method used should not interfere with the effect of the salt mist on the specimen, nor introduce any secondary corrosion. Touching of the test surfaces by hand should be avoided as far as possible before the test.

CC-8 TESTING

CC-8.1 The specimen shall be placed in the salt mist chamber, and sprayed with the salt solution, for a period of 2 h at a temperature between 15°C and 35°C.

CC-8.2 The salt mist conditions shall be maintained in all parts of the exposure zone, that a clean collecting receptacle with a horizontal collecting area of 80 cm², placed at any point in the exposure zone, shall collect between 1.0 ml and 2.0 ml of solution per hour, averaged over the collecting period. A minimum of two receptacles shall be used. The receptacles shall be placed such that they are not shielded by the specimen and so that no condensate from any source shall be collected.

NOTE — When calibrating the spray rate of the chamber, a minimum spray period of 8 h should be used, for accurate measurement purposes.

CC-8.3 Severities (1) and (2)

At the end of the spray period, the specimen shall be transferred to the humidity chamber and stored at a temperature of 40 ± 2°C and a relative humidity of 93 ± 3 percent in accordance with IS 9000 (Part 4).

The spraying with salt solution as in 9.1 and the storage as in this sub-clause constitutes one cycle.

The required severity for the number of cycles and the duration of storage shall be in accordance with 6.2.

CC-8.4 Severities (3) to (6)

At the end of the spray period, the specimen shall be transferred to the humidity chamber and stored at a temperature of 40 ± 2°C and a relative humidity of 93±3% in accordance with IS 9000 (Part 4) for a period of 20 to 22 h. This shall be repeated a further three times.

The specimen shall then be stored under a standard atmosphere for testing at 23 ± 2°C and 45 percent to 55 percent relative humidity for a period of three days.

The four spray periods (see CC-8.1) and storage periods of this subclause followed by three days under a standard atmosphere for testing constitutes one test cycle.

The required severity for the number of test cycles shall be in accordance with 6.2.

CC-8.5 The removal of the specimen from the salt mist chamber to the humidity chamber shall be carried out so as to minimize the loss of salt solution from the specimen(s).

NOTE — If the salt mist chamber can maintain the humidity and temperature conditions of IS 9000 (Part 4), the specimen may remain in it for the humidity storage period.

CC-8.6 If the specimen consists of more than one item they shall not be in contact with each other or with other metal parts and shall be so arranged as to exclude any influence of one part upon another.

CC-9 RECOVERY (AT THE END OF TESTING)

The relevant specification shall state whether or not the specimen shall be washed. If the specimen is to be washed, it shall be washed in running tap water for 5 min, rinsed in distilled or demineralized water, shaken by hand or subjected to air blast to remove droplets of water, then dried for 1 h at 55 ± 2°C and allowed to cool under controlled recovery conditions 4.4.1 of IS 9000 (Part 1) for not less than 1 h and not more than 2 h.

The relevant specification shall specify, if needed, other methods to be used for washing and drying the specimen. It shall be stored under controlled recovery conditions 4.4.1 of IS 9000 (Part 1) for not less than 1 h and not more than 2 h. The temperature of the water used for washing shall not exceed 35°C.

CC-10 FINAL MEASUREMENTS

The specimen shall be submitted to the visual, dimensional and functional checks prescribed by the relevant specification. The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen is to be based.

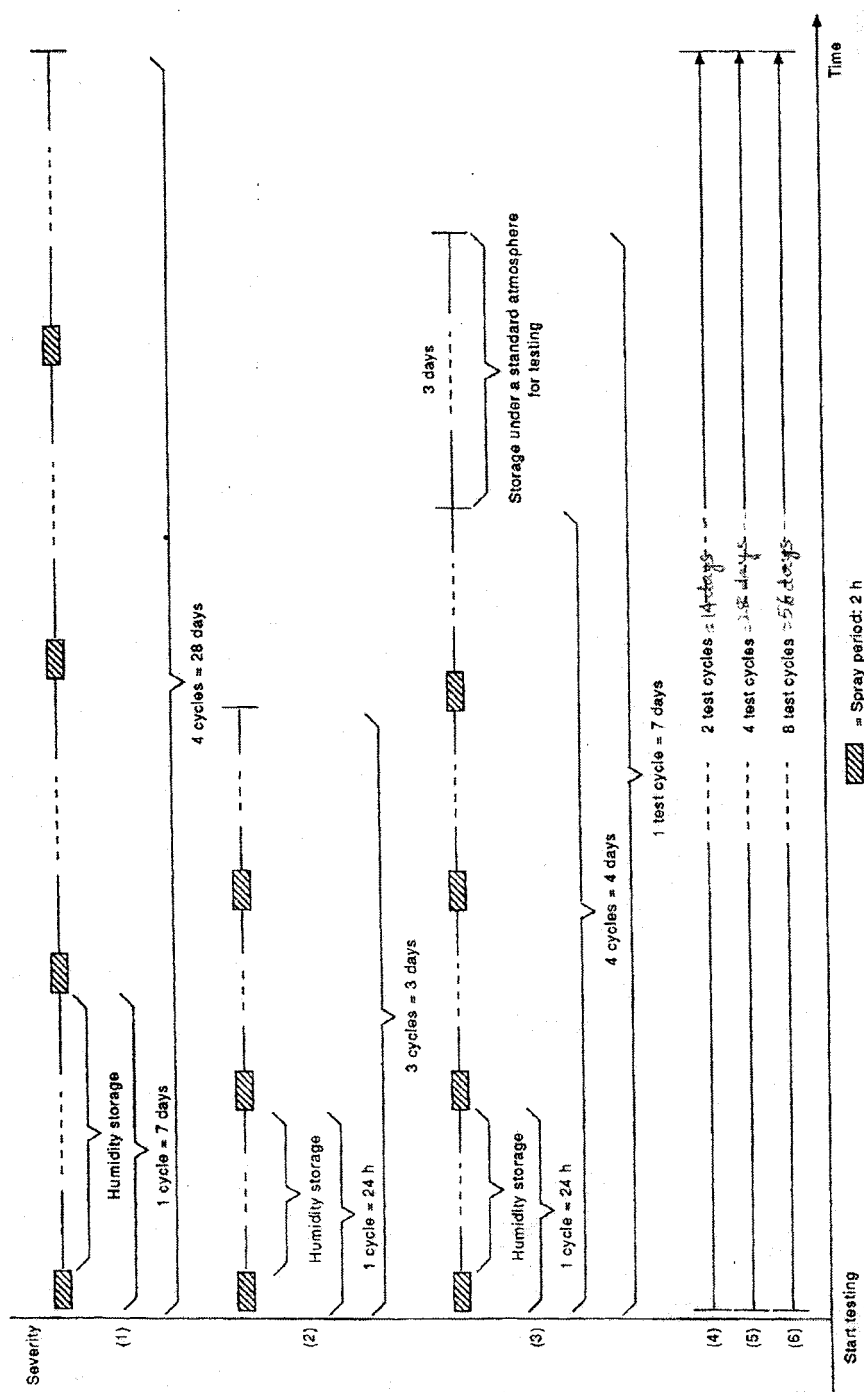


FIG. CC-1 — TIME-SCALE OF THE DIFFERENT TEST SEVERITIES (1) TO 95)

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